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CLIMATE PREDICTIONS and the MANTEL ITN

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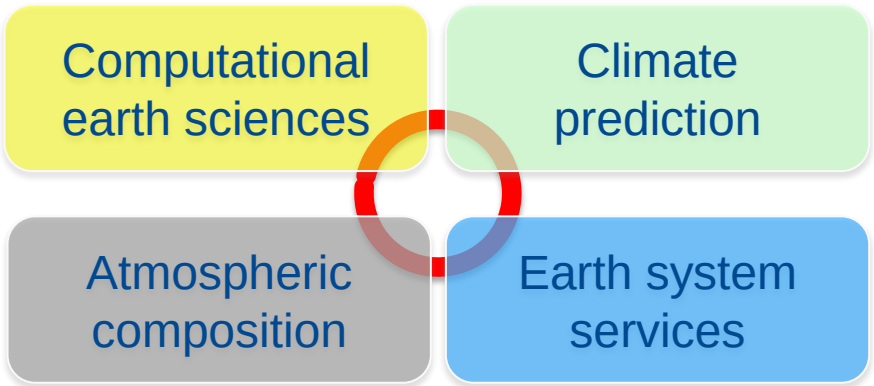
EXCELENCIA SEVERO OCHOA

- Created in 2005; 450 employees
- Research, develop and manage information technology
- Facilitate scientific progress and its application in society

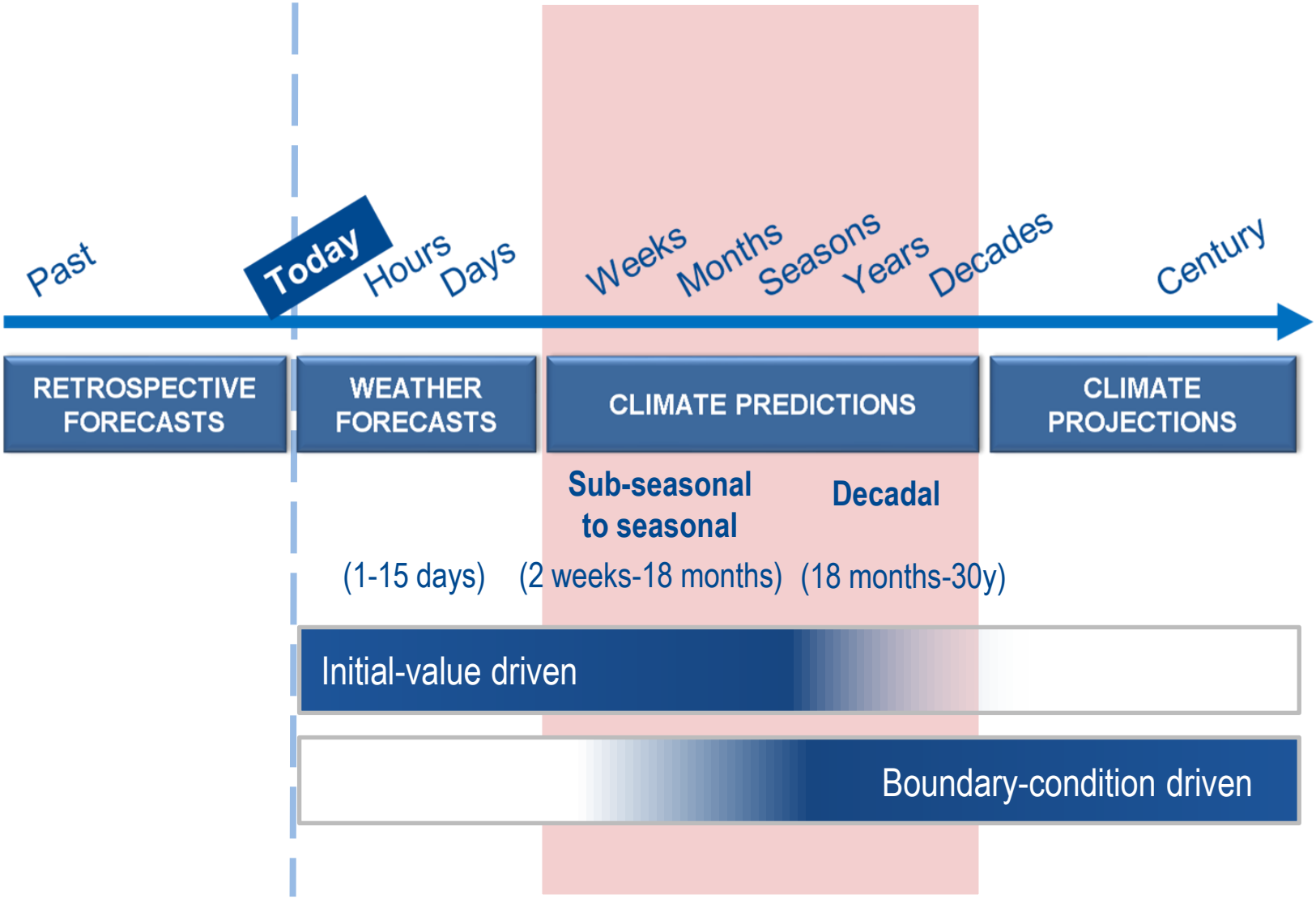
Earth Sciences Department



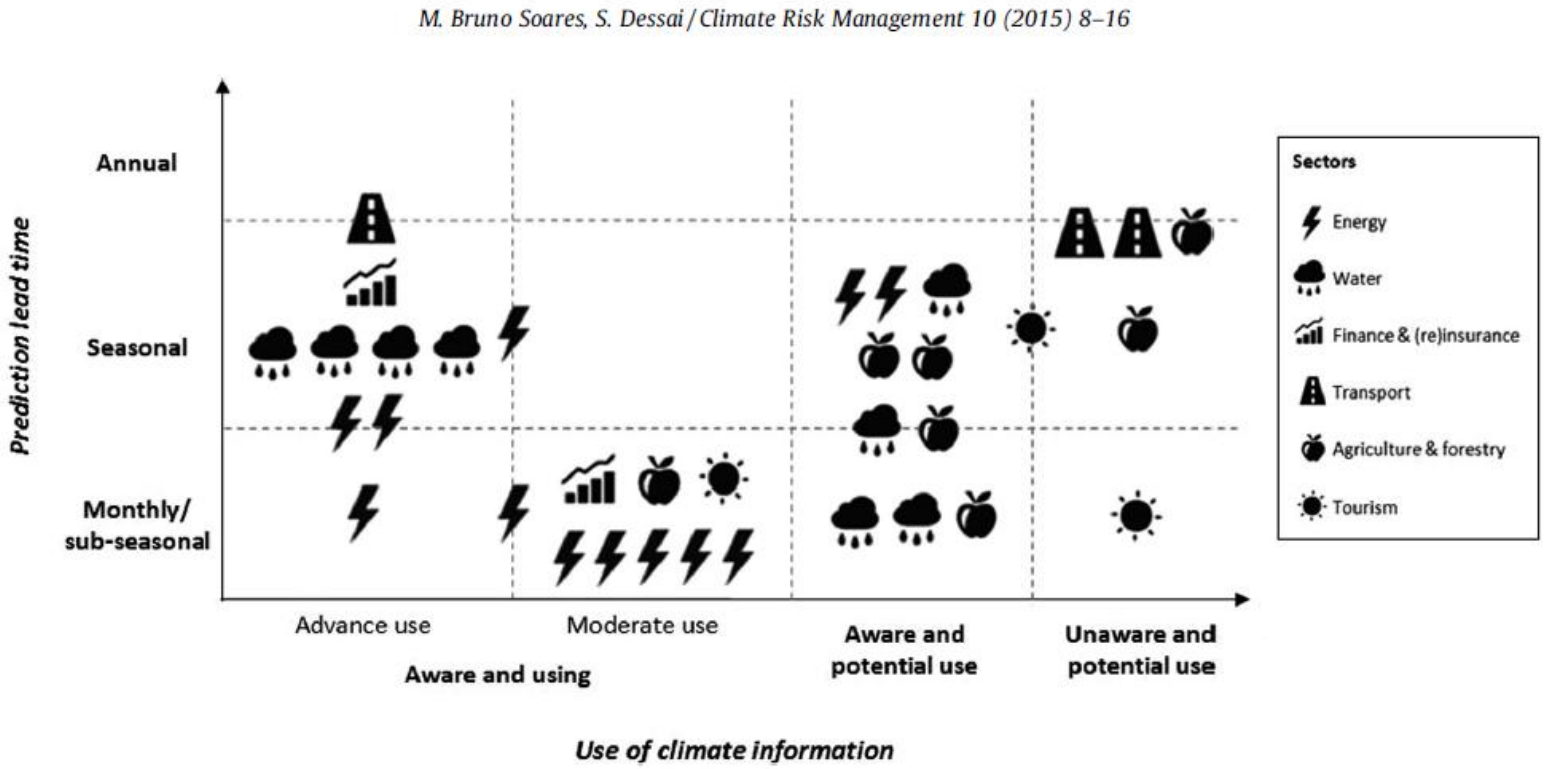
Outline

- **Introduction to climate predictions** & their application to key sectors of the society
- **Predictability** of seasonal forecast simulations
- **Potential applications** of climate predictions to agriculture and water management. Related projects
- **Preliminary results**
- **Conclusions**

Temporal horizons of climate science



Use of climate predictions in Europe



Because prediction quality (skill) and reliability in Europe is low & varies depending on:

(1) geographical area,
(2) time of the year
(3) the climate variable

Seasonal forecast predictability

How can we predict climate for the coming season if we cannot predict the weather next week?

WEATHER FORECASTS

The forecasts are based on the initial conditions of the **atmosphere**, which is highly variable and develops a chaotic behaviour after a few days

CLIMATE PREDICTIONS

The predictions are based on the initial conditions of the **sea surface temperature**, **snow cover** or **sea ice**, which have a slow evolution that can range from few months to years

TRADITIONAL APPROACH

Traditionally, the users apply **retrospective climatology** (i.e. the average conditions of the last 30 years) in order to have an estimation of the expected values of climate variables.

LIMITATIONS:

- Assumption that **future conditions will be similar to past** conditions
- Based on **a finite sample of events** (limited in time, not fully representative of what can happen in the future)
- **Neglect atmosphere dynamics** such as those caused by climate change
- **Can not predict events that have never happened before**

Sources of seasonal predictability

ENSO is the most important source of predictability at seasonal timescales (Doblas-Reyes et al. 2013). Other sources: the North Atlantic Oscillation, etc.

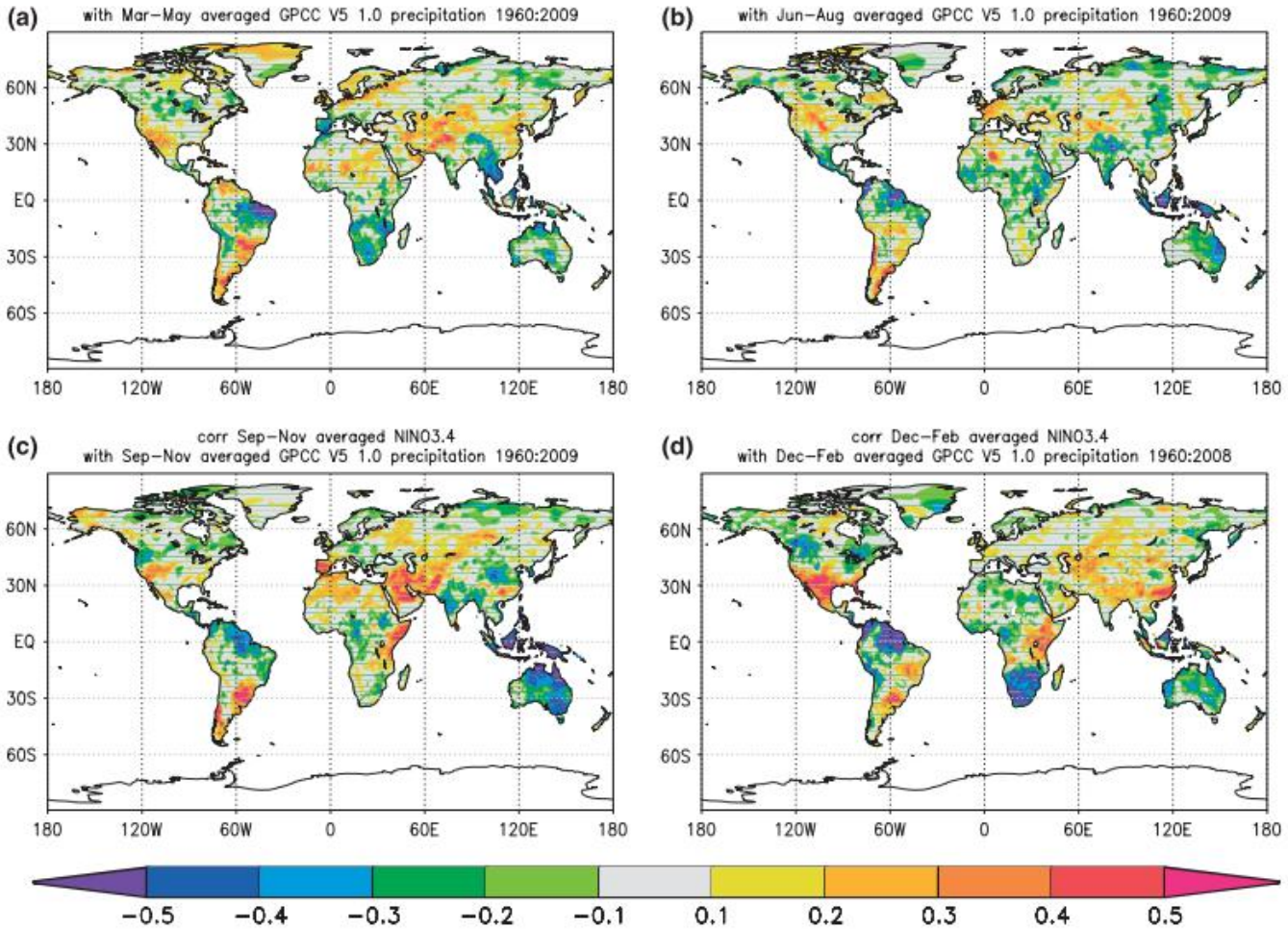


FIGURE 1 | Correlation between the ERSST[38] SST Niño 3.4 index (average temperature over 5°N–5°S, 170°–120°W) and the GPCCv5[39] gridded precipitation over the period 1960–2009. (a) March to May, (b) June to August, (c) September to November, and (d) December to February.

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APPLICATIONS

Application to key sectors

Climate service for wind energy

Climate service for insurance

www.project-ukko.net

www.seasonalhurricanepredictions.org

Potential applications

AGRICULTURE

JRC EUROPEAN COMMISSION — Seasonal – food security

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD — HIATUS

Interanual to decadal - wine

Copernicus — SECTEUR

User engagement and information requirements – wine

HORIZON 2020 — VISCA

Vineyard's integrated smart climate application – seasonal to decadal - wine

ERA4CS European Research Area for Climate Services — INDECIS

User-oriented climate indicators - wine

WATER

HORIZON 2020 — imprex

Anticipate and respond to future hydrological extreme events

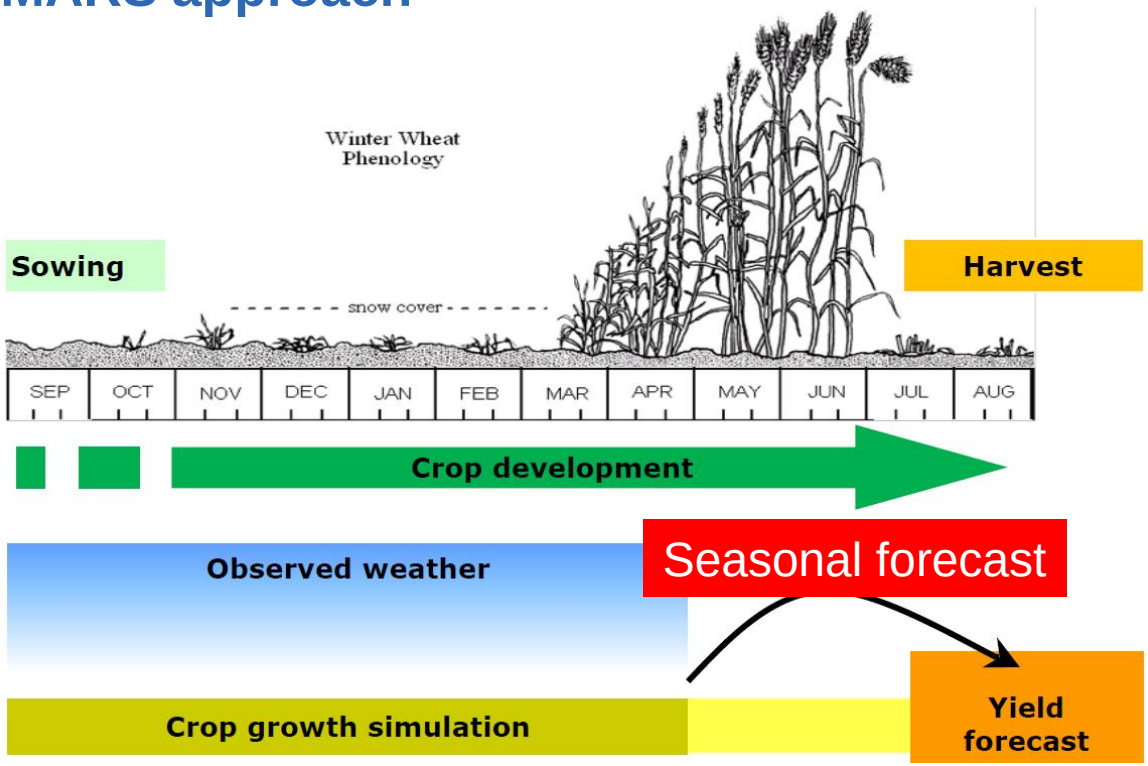
HORIZON 2020 — climateurope Linking science and society

Support European initiatives for better management of climate-related risks

Climate predictions for agriculture

Testing seasonal forecast for MARS: BSC and JRC are exploring how the MARS Crop Yield Forecasting System (MCYFS) could ingest the seasonal forecast for a future operational use

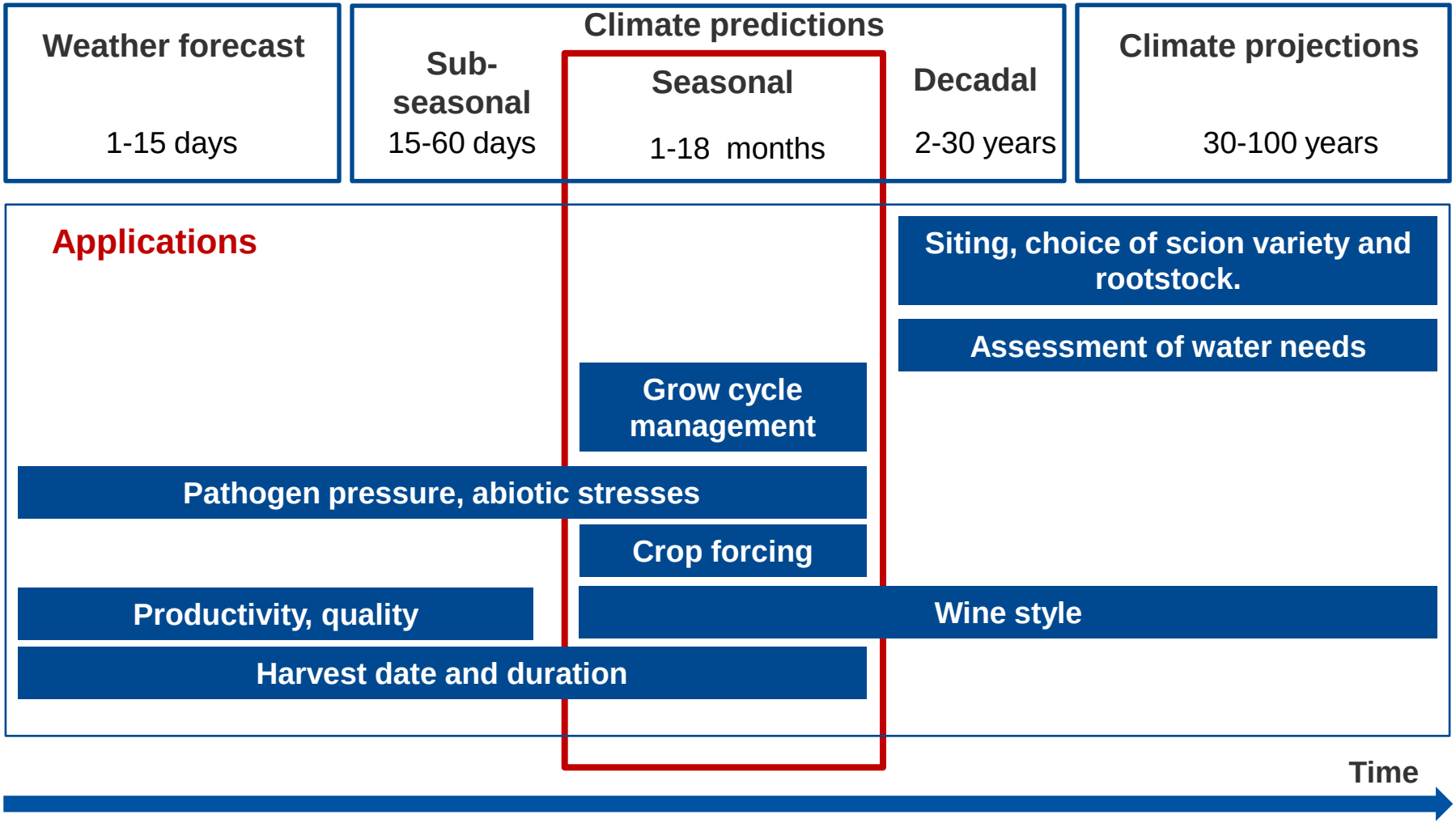
MARS approach



Source: Toreti, 2015. EUPORIAS

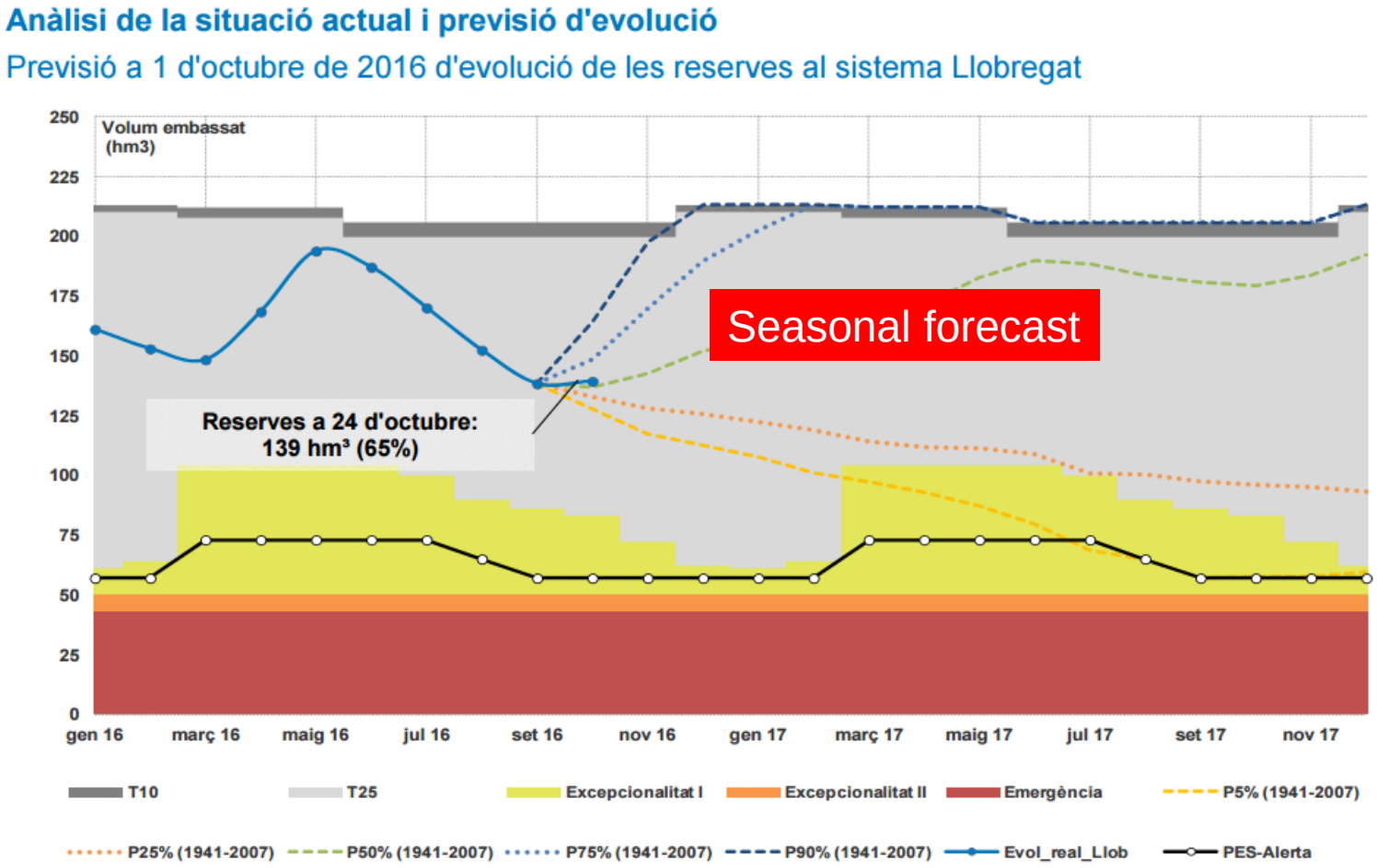
Climate predictions for agriculture

Vineyard



Adapted from: Antonio Graça, Sogrape Vinhos SA, 2014

Predicting the evolution of water reserves

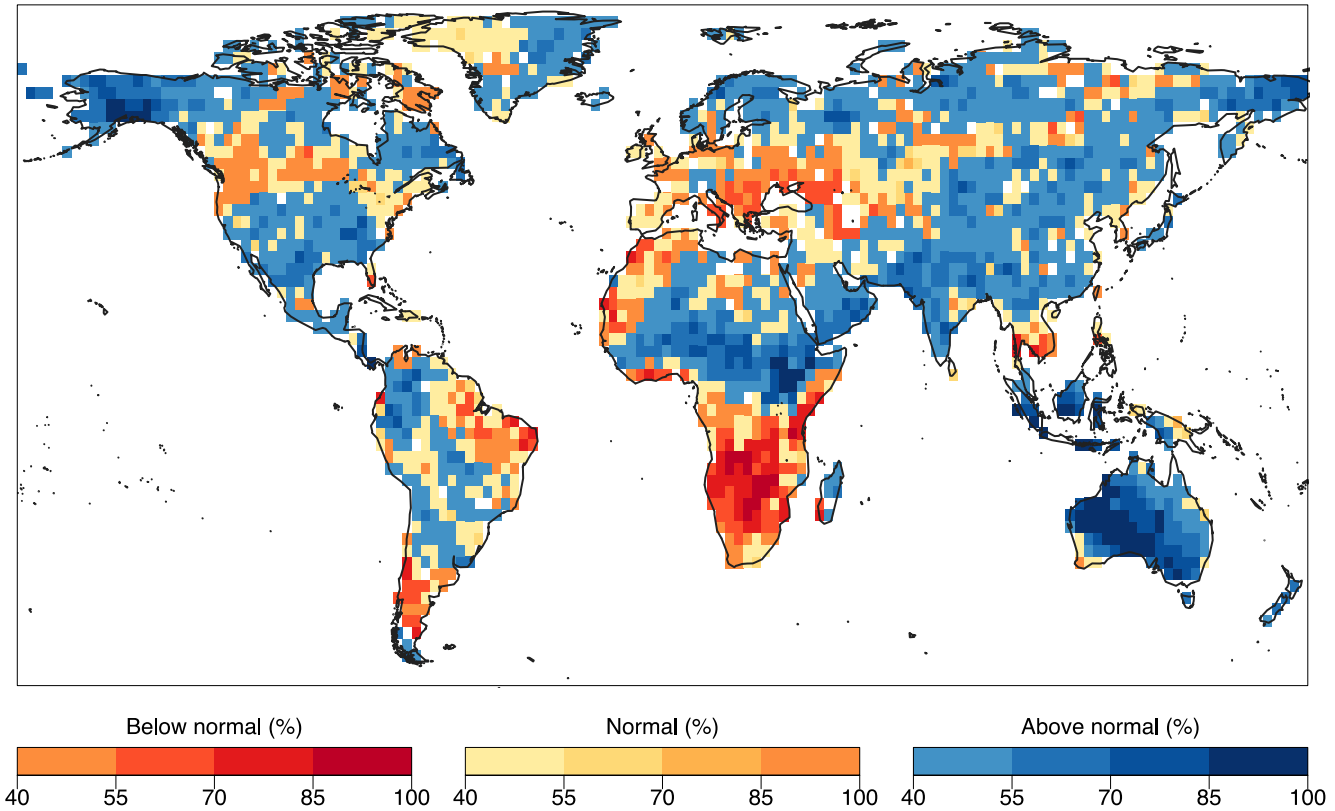


Source: Catalan Water Authority (ACA)

PRELIMINARY RESULTS

Probabilistic predictions

Which type of information?

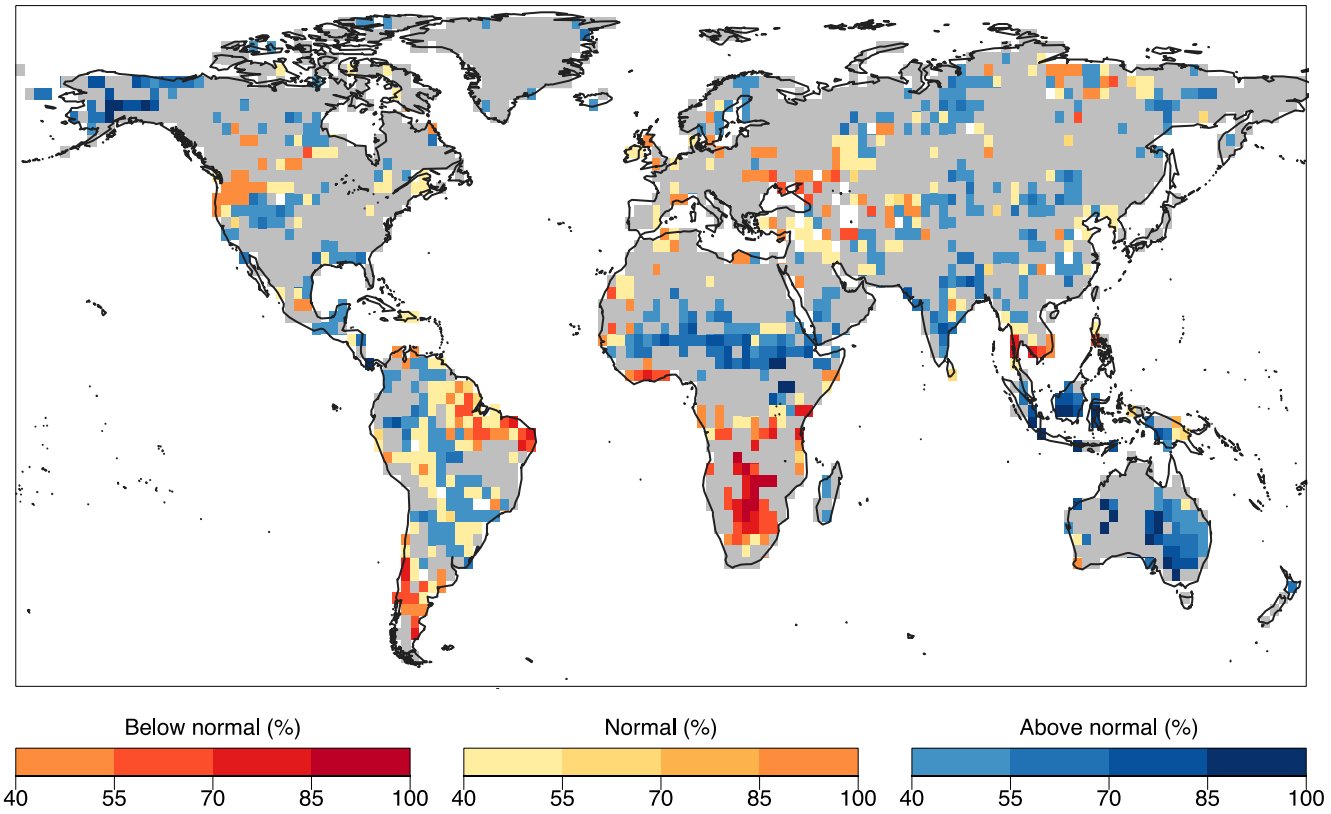


Source: Marco Turco, BSC

- ECMWF-S4 precipitation forecast for MJJA 2016 (init. April).
- Most likely precipitation category (below-normal, normal or above normal) and its percentage probability to occur.
- White areas (over land): probability <40 % and approximately equal for all three categories.

Probabilistic predictions

But this information needs to be compared to a reference model, i.e. climatology (average conditions over the last recent years, ~30 years)

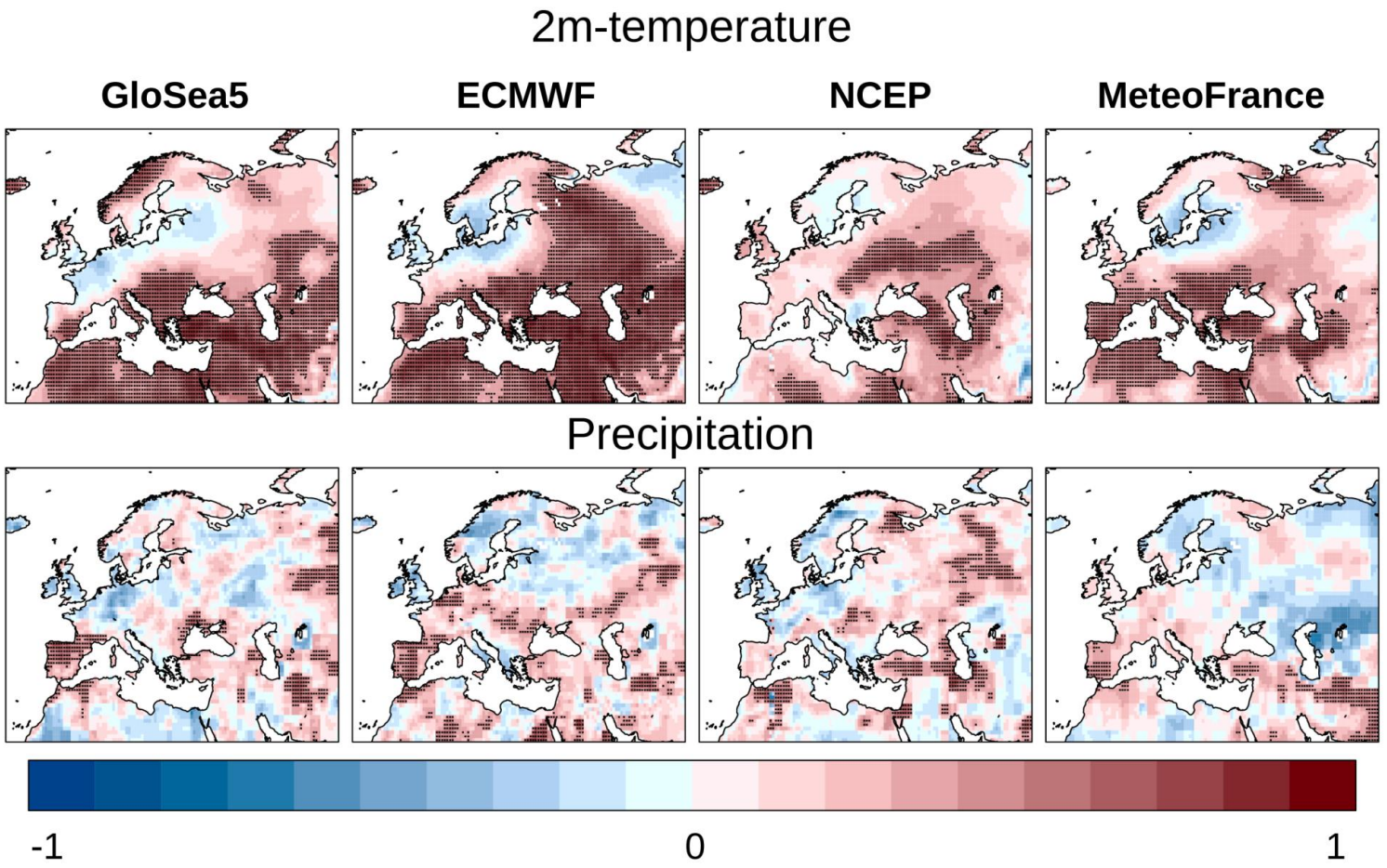


Source: Marco Turco, BSC

- Grey areas: where the climate prediction model doesn't improve the climatology. In this areas, the model has no skill

Skill of individual systems

Summer correlation map for seasonal temperature and precipitation over Europe

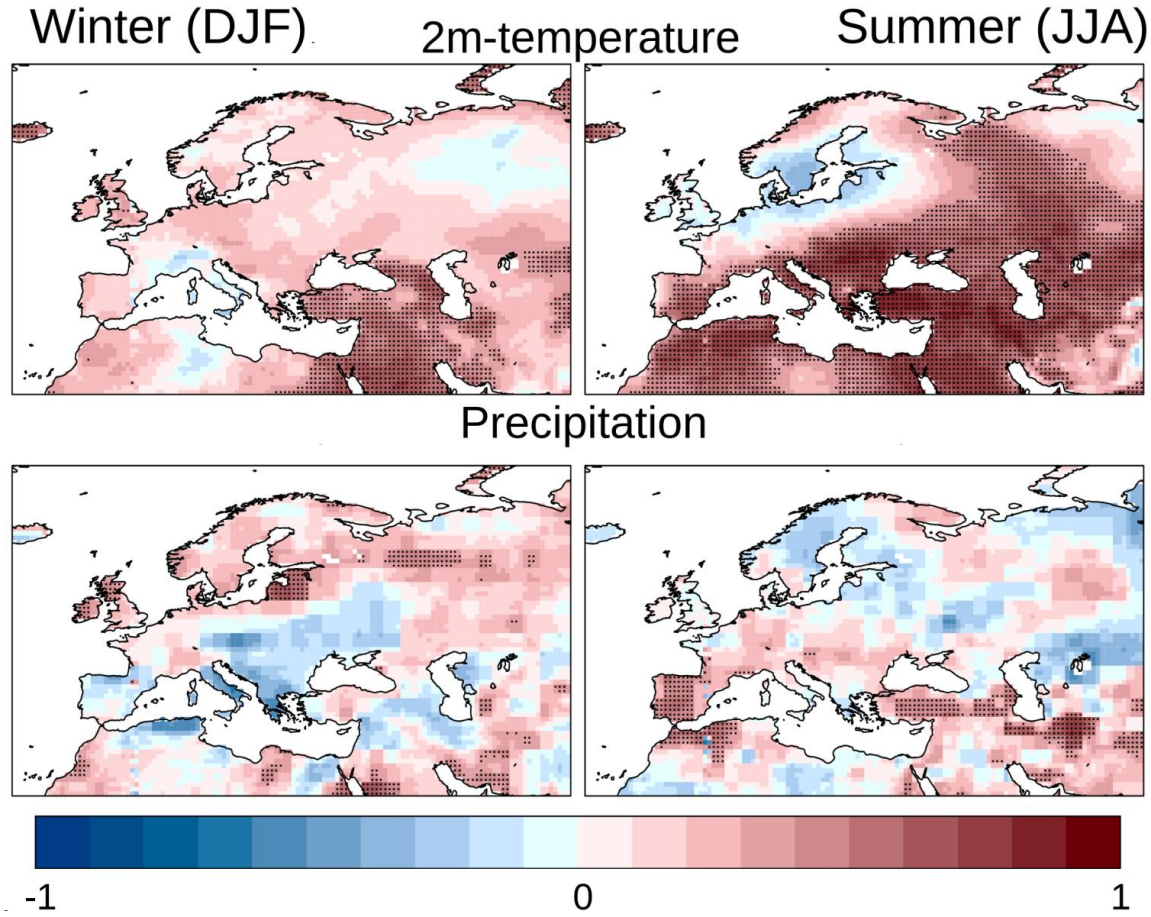


Source: Niti Mishra, BSC

- Period: 1992-2012
- Prediction: Summer June-July-August (initialized in May 1)
- Observations: temperature/ERA-Interim; precipitation/Global Precipitation Climatology Project
- Darker areas: regions where the correlation is significant

Skill of multi-model mean

Correlation map for seasonal temperature and precipitation over Europe - Average



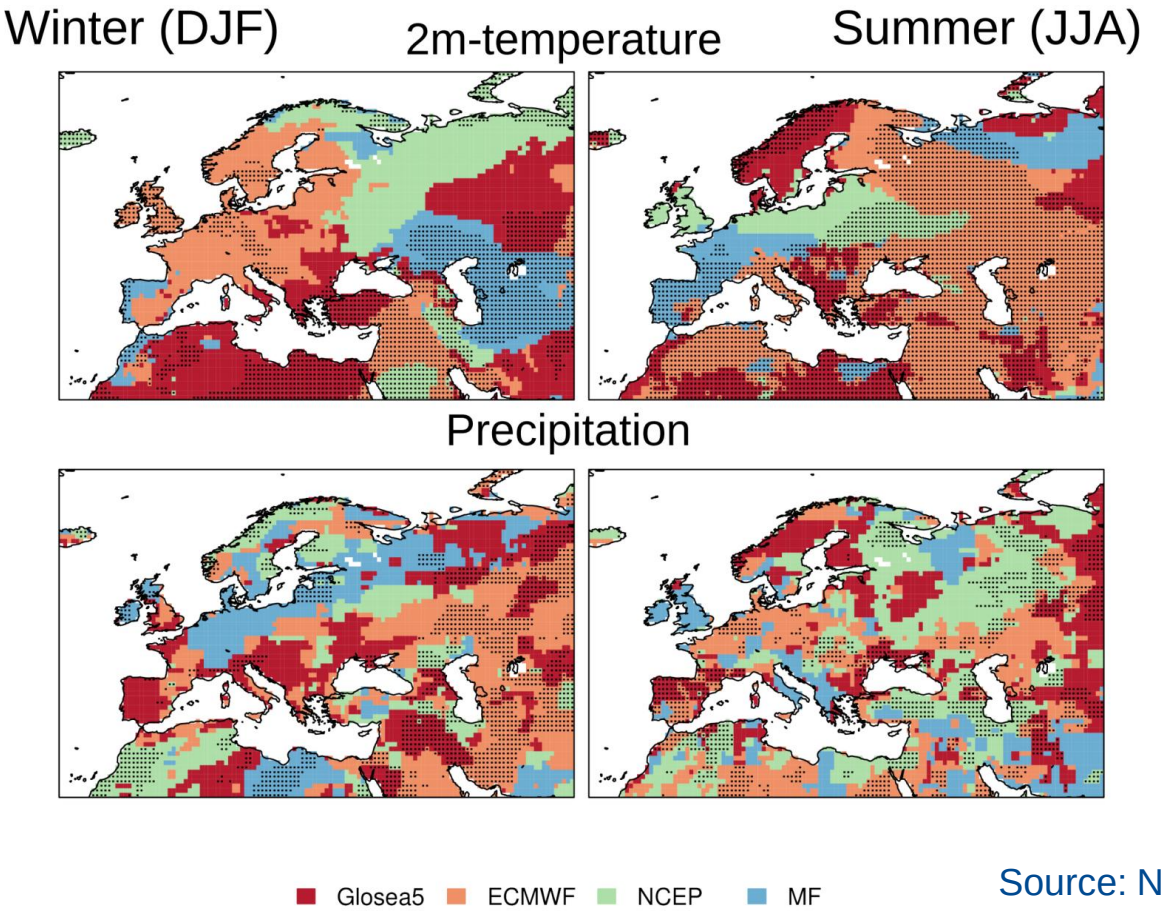
- Temperature: better predicted in Summer
- Precipitation: the quality of the prediction changes for the different seasons and according to the geographical area

Source: Niti Mishra, BSC

- Period: 1992-2012
- Prediction: Summer June-July-August (initialized in May 1)
- Observations: temperature/ERA-Interim; precipitation/Global Precipitation Climatology Project
- Darker areas: regions where the correlation is significant

Which is the ‘best’ system?

Recommended: a weighting of all of them



- Whereas some models can predict better in some regions, other models would provide a better prediction for some other regions

- A weighting of all models recommended

Source: Niti Mishra, BSC

- Period: 1992-2012
- Prediction: Summer June-July-August (initialized in May 1)
- Observations: temperature/ERA-Interim; precipitation/Global Precipitation Climatology Project
- Darker areas: regions where the correlation is significant

Conclusions

- Some climate-sensitive sectors routinely use weather forecast up to 15 days. Beyond this time horizon climatological data are used. However, climatology approaches assume that future conditions will be similar to past conditions and are based on a finite number of past events. Climatological approaches are therefore, unable to predict events that have never happened before, i. e. extreme events.

- Climate predictions have some skill in predicting climate anomalies. However, over Europe poor forecast skill is currently observed, especially regarding seasonal rainfall forecasts.

- However, preliminary results detected a window of opportunity (forecast skill) locally over southern and eastern Europe. This level of skill may be useful for sectors impacted by climate variability, such as water management and agriculture.

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QUESTIONS?

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Thank you!

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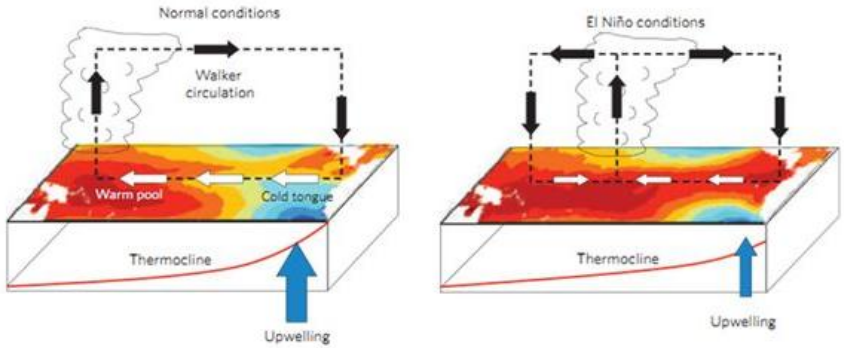
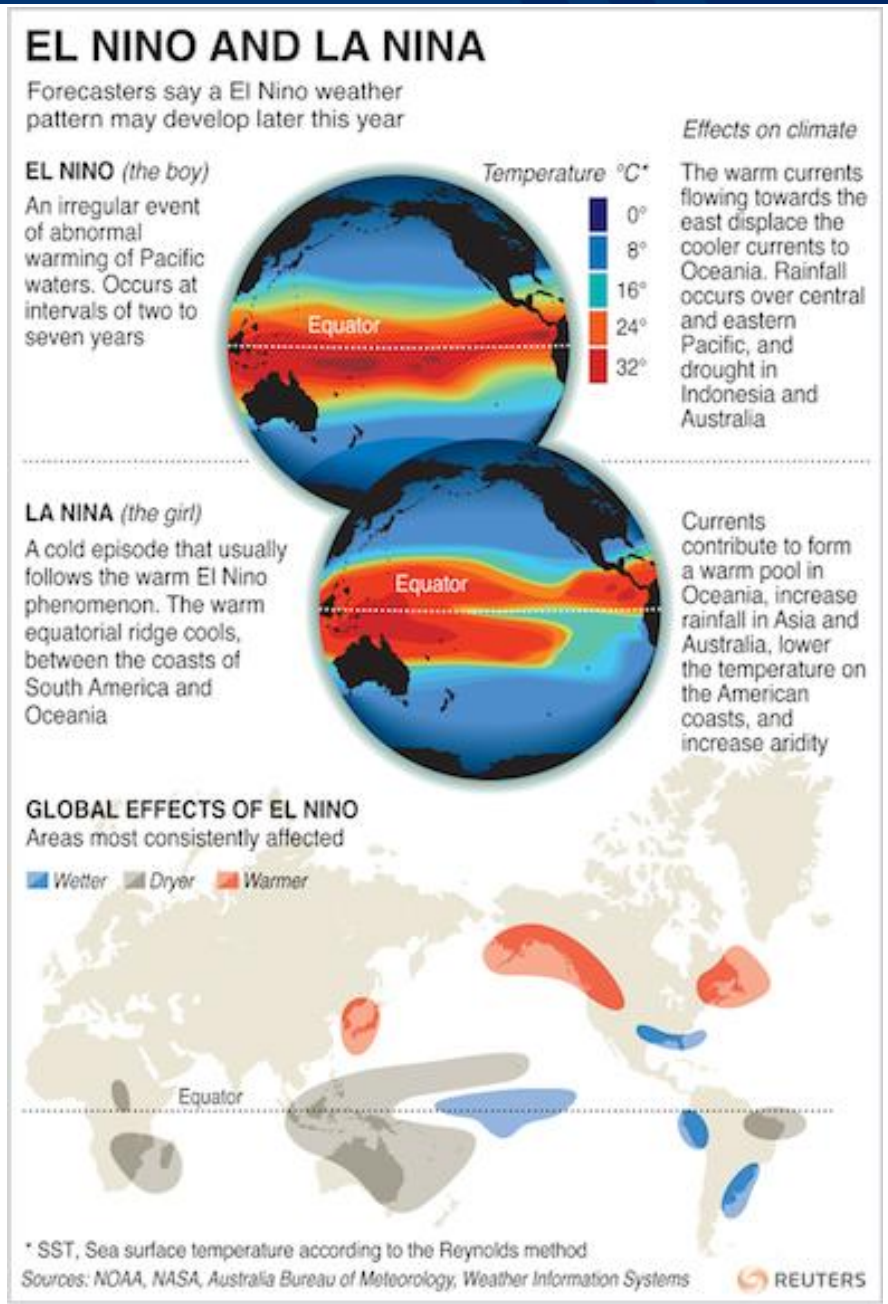
ENSO

What is ENSO?

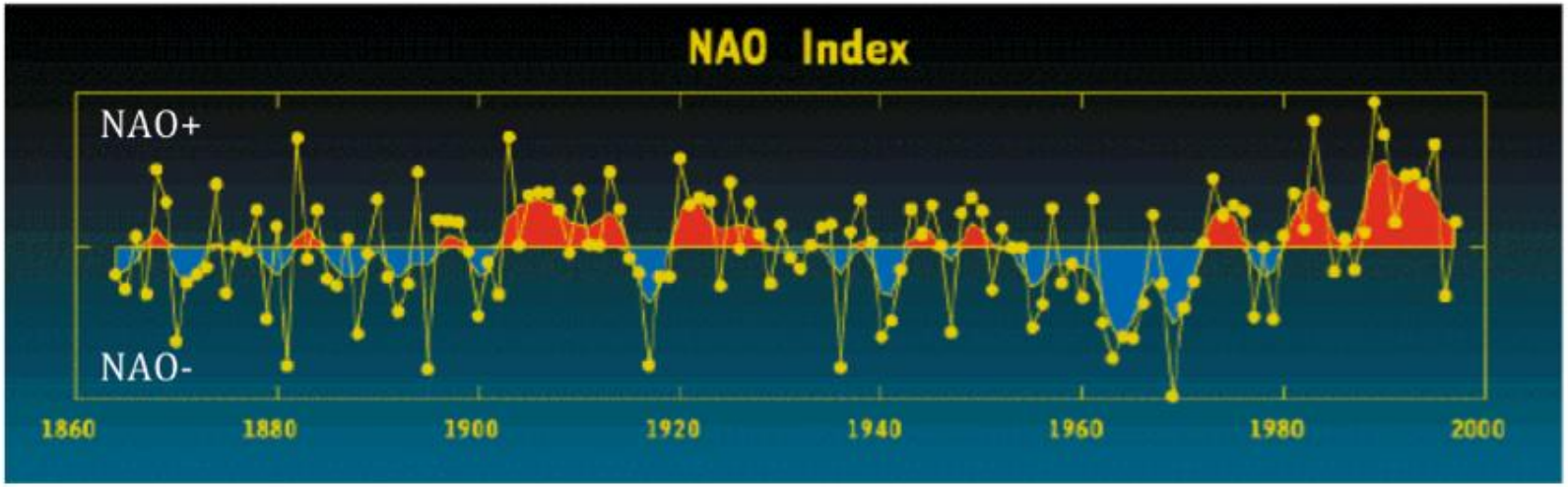


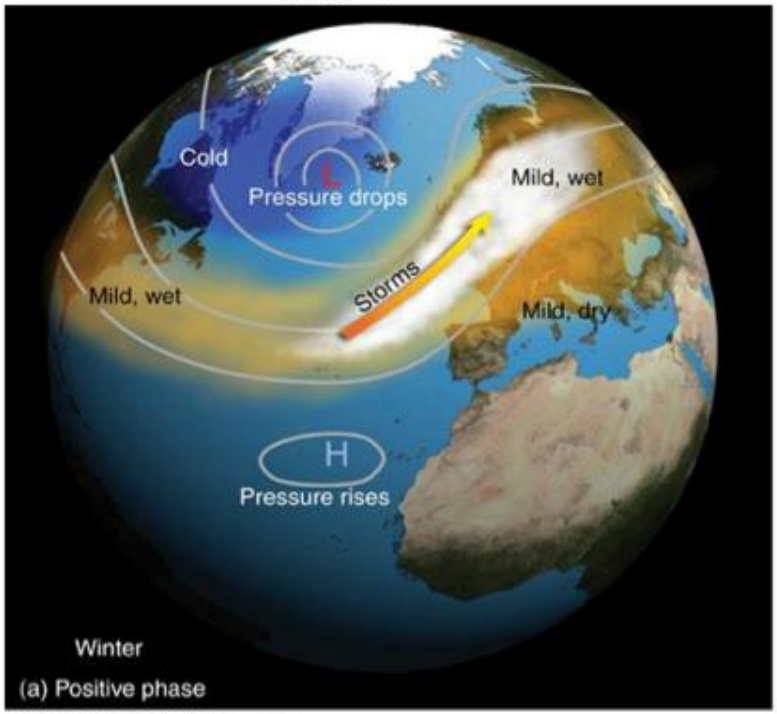
- Naturally occurring variation in climate in the tropical Pacific region between abnormally warm (El Niño) and abnormally cold (La Niña) conditions

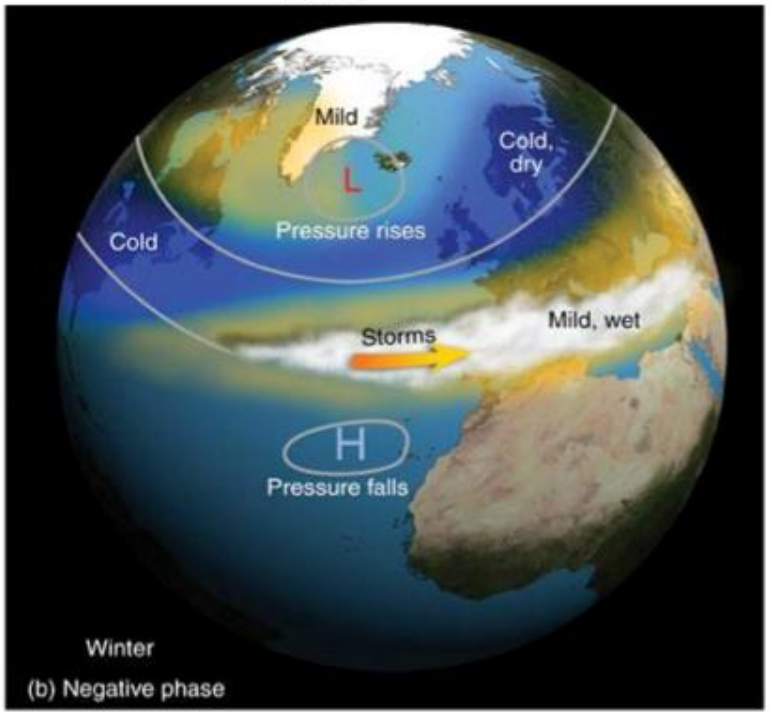
- Oscillation of the of the ocean-atmosphere system with important consequences for weather across the globe



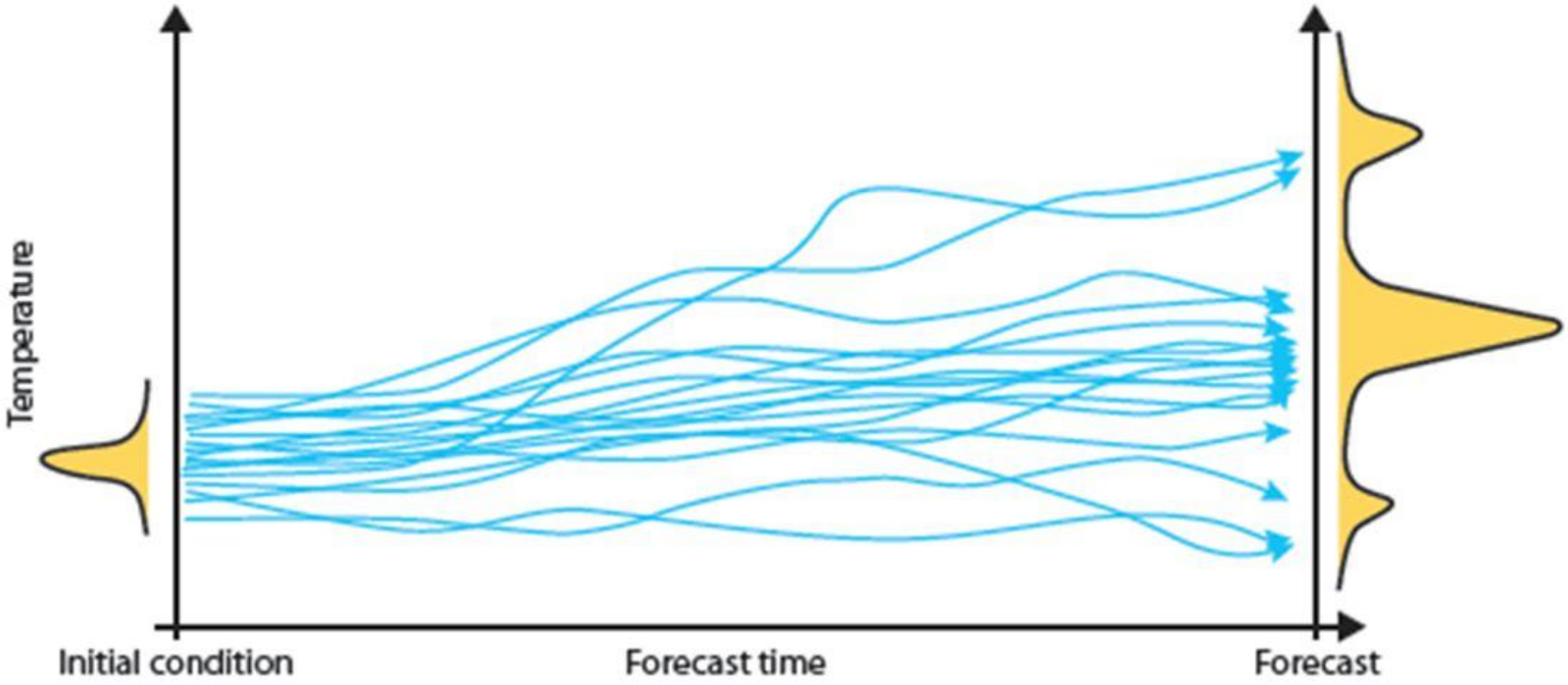
North Atlantic Oscillation







Ensemble forecasting

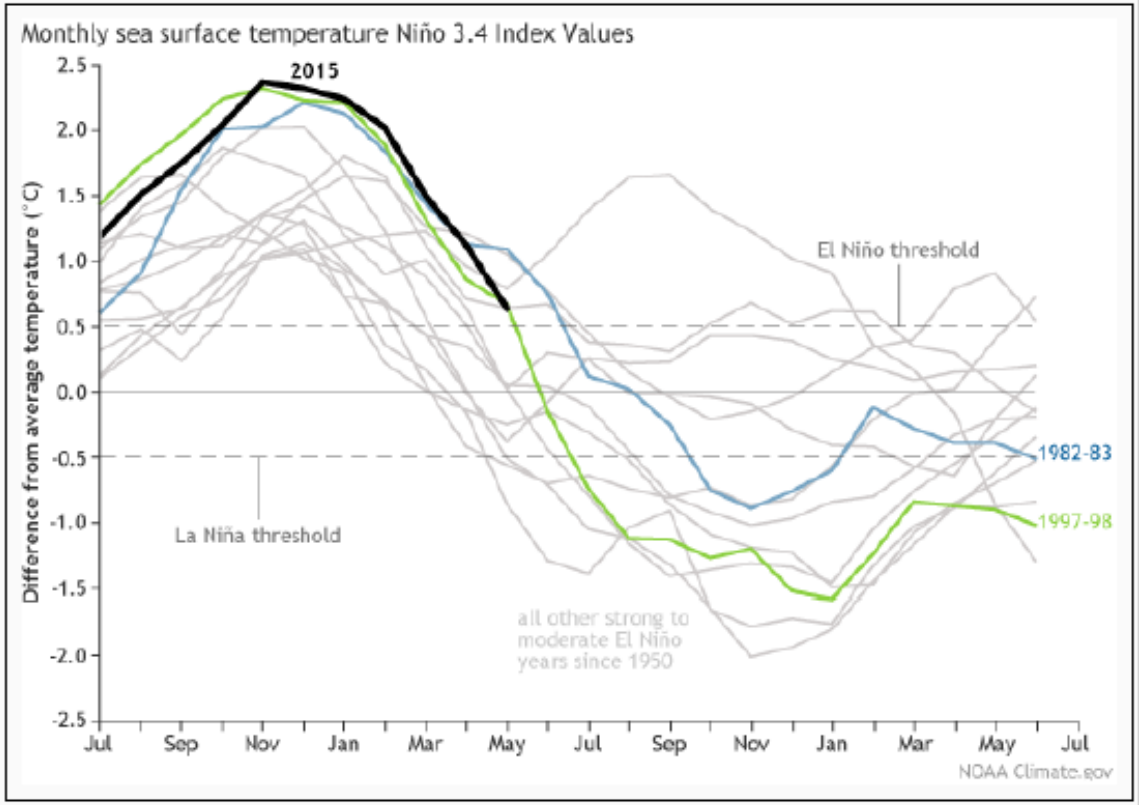


Source: https://probabilisticforecasting.wordpress.com

- Initial condition perturbation
- The ensemble spread gives information about the prediction error

Sources of predictability

1. North Atlantic Oscilation (NAO)
2. El Niño Southern Oscillation (ENSO) ⟶
3. Soil Moisture
4. Snow Cover
5. Anthropogenic Green House Gases (GHGs)
6. General Circulation Models
7. Statistical Models



Source: http://www.ecy.wa.gov

Types of variables & start dates

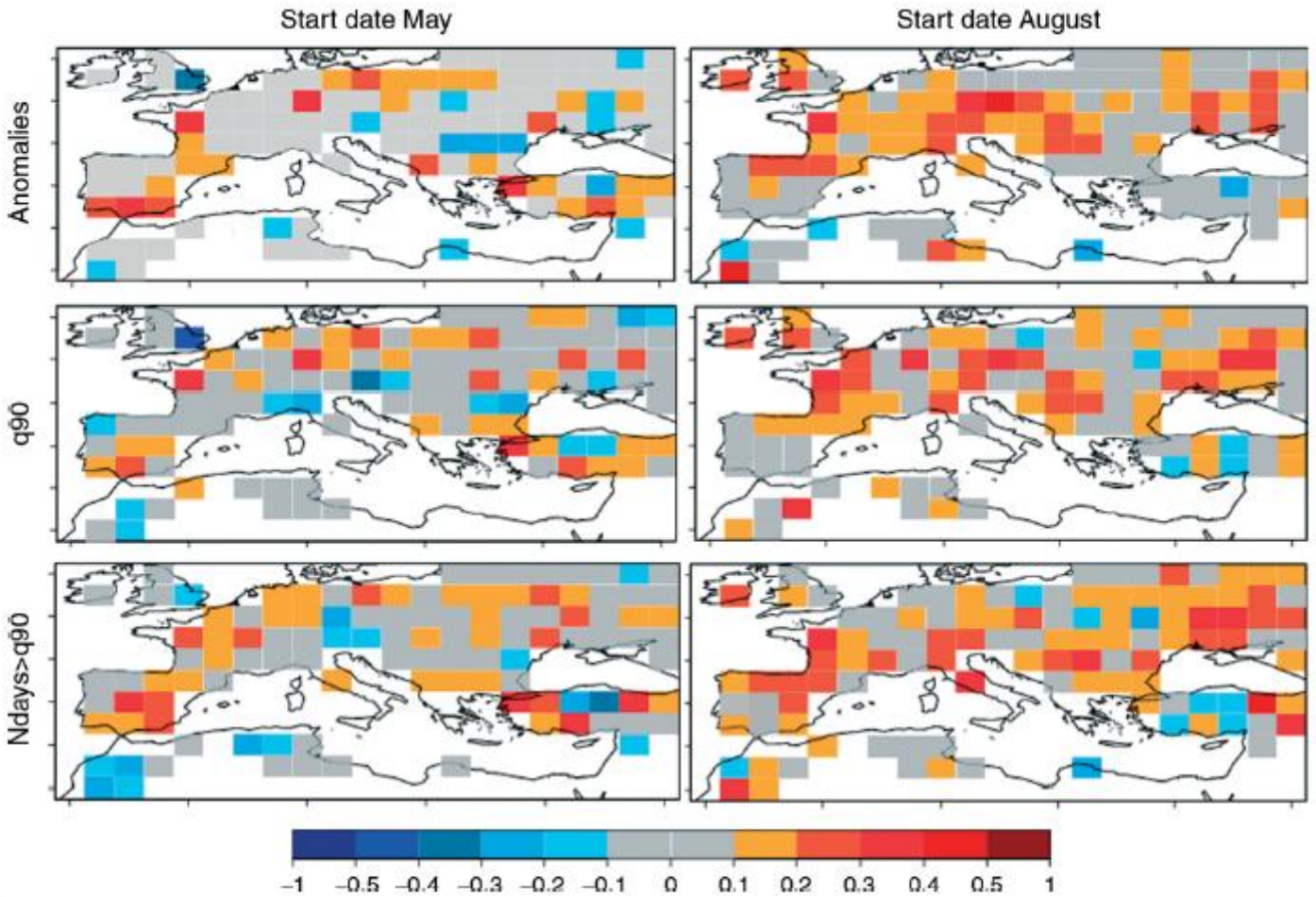


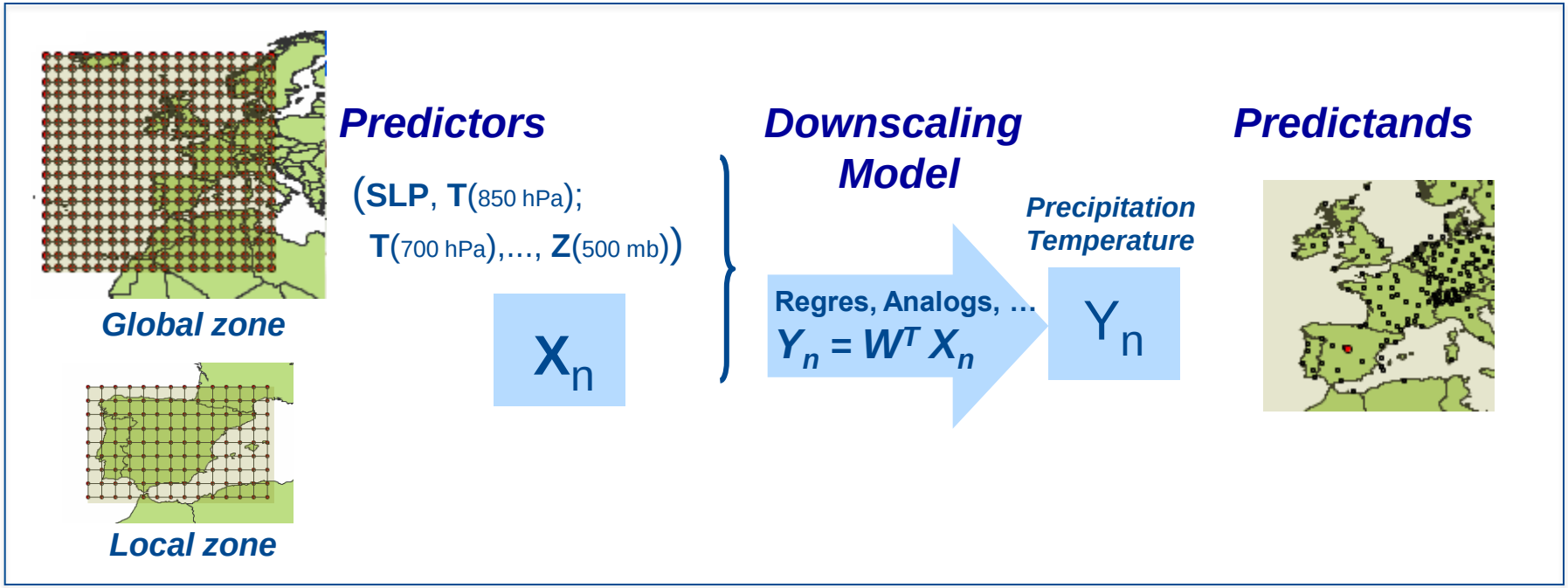
FIGURE 6 | Correlation of the ensemble mean of the predictions of total monthly precipitation, the 90th percentile of the daily precipitation and the number of days in a month where the precipitation is larger than the 90th percentile of the climatological distribution of the month of August for the 3-month (May start date, forecast time 4 months, left column) and zero-month (August start date, forecast time 1 month, right column) lead time seasonal predictions of the perturbed-parameter DePreSys system. The predictions were performed over the period 1960–2005 and verified against the E-Obs data set[151] interpolated bilinearly on the DePreSys grid.

Source: Doblas-Reyes et al. (2013)

Bias correction/downscaling

Perfect prognosis approach:

- In the training phase the statistical model is calibrated using observational data for both the predictands and predictors (e.g. reanalysis data)
- Typical techniques: transfer functions, analogs, weather typing, weather generators, etc. (Maraun et al. 2010)



Source: José M. Gutiérrez, University of Cantabria

Vineyard cycle